

Global Alignment

Comparing with MinJung's corrections

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April 19, 2006

Outline

General idea

Run3pp no field

Order of magnitude of the misalignments

Residuals

Track χ^2/ndf

Applying corrections on run4pp with field

Residuals

Track χ^2/ndf

Conclusion

Todo

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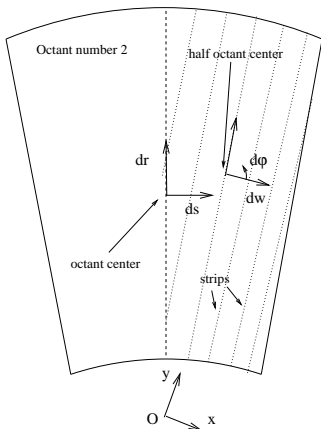
General idea

The global alignment gives the best alignment corrections to optimise the track's quality for the studied run.

Details on the algorithm used can be found in the previous presentation given at the PR meeting :
<https://www.phenix.bnl.gov/cdsagenda/fullAgenda.php?ida=a05290&fid=30>

Alignment parameters

- In order to validate a step in the method, we decided to limit ourselves to the same choices as MinJung. We would then see if the algorithm works better or worse than what already exists, and at what time costs.
- Minjung found corrections only for station 2, and along ds and dr , so we focused on the alignment of this station, along w .



dr is a misalignment in the radial direction for each octant, taken at the middle of the octant. It makes an angle, ϕ with x .

ds is a misalignment perpendicular to dr .

dw is a misalignment perpendicular to the strips, at the half octant center.

With dw misalignments of 2 half octants of an octant, and the angle between the strips and (O, x) , one can retrieve the octant misalignments along x and y . When the strips are parallel for 2 half octant of an octant (stereo planes), only dw is defined and is equal to ds .

Steps of the study

The study was made as follow:

- 1 Reconstruction with no corrections;
- 2 Reconstruction with Minjung corrections;
- 3 Reconstruction with Millepede corrections.

In the following slides, we focus on comparing

- a- The order of magnitude of the misalignments;
- b- The residuals in each detector after reconstruction;
- c- The χ^2/ndf for each half octant after reconstruction.

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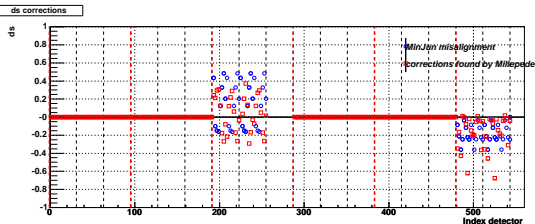
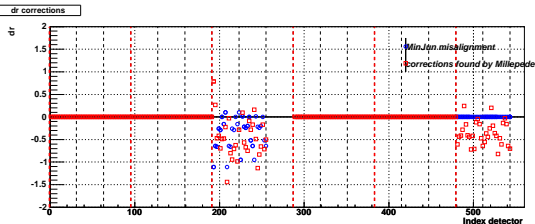
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Comparing the misalignments



Comments:

MinJung's corrections for ds go 4 by 4 in south arm: they are the same for all cathodes for a specific octant.

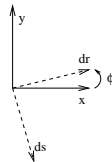
The corrections found by Millepede have the same order of magnitude as MinJung's.

Legend:

In blue are the misalignments found by MinJung; **In red** the ones found by Millepede.

Each entry corresponds to one octant, going from left, south arm station 0 to 2, then north arm station 0 to 2.

The upper plot compares dr corrections, and the bottom one, ds corrections.

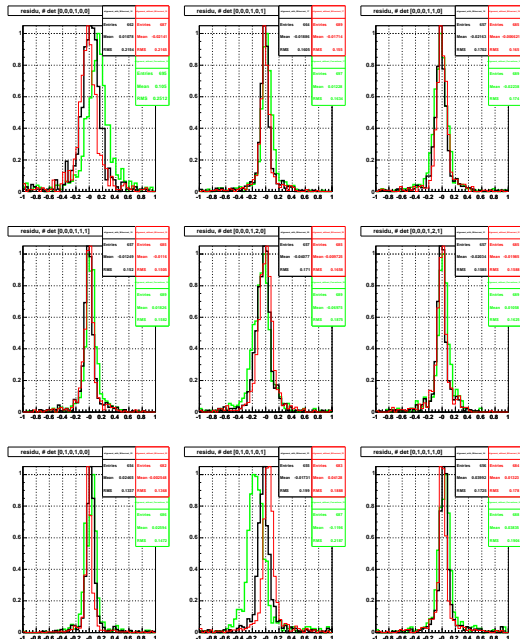


To derive (ds, dr) from (dx, dy), we used the following relations:

$$dr = x \cos(\phi) + y \sin(\phi)$$

$$ds = x \sin(\phi) - y \cos(\phi)$$

Typical residuals for a cathode

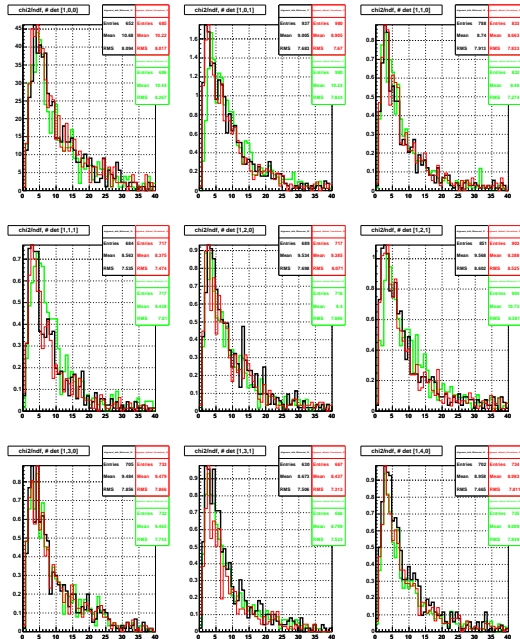


- Legend:** Some of the residuals of a mutr cathode representative of the others, with/without corrections. In the global alignment method, each half octant is aligned separately. Each plot represents the residuals in a half octant (index of the detector:[arm, station, octant, half, gap, cathode]).

- Legend:** In green, tracks without any corrections. In black, reconstruction with MinJung's corrections. In red, the tracks with Millepede's corrections.

- Comments:** The residuals are better with corrections. Millepede's corrections improve slightly more the residuals than MinJung's corrections.

Track χ^2/n_{df}



- **Legend:** The χ^2/n_{df} has been plotted for each half octant, here in the north arm. Detector index:[arm, octant, half].
- **Legend:** **In green**, track chisquare without any corrections. **In black**, reconstruction with MinJung's corrections. **In red**, the tracks have been corrected with the misalignments found by Millepede.
- **Comments:** The track χ^2 per degree of freedom is slightly better with Millepede corrections.

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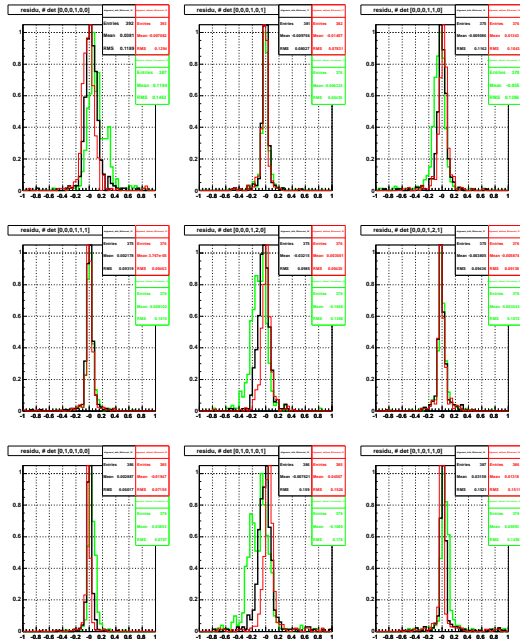
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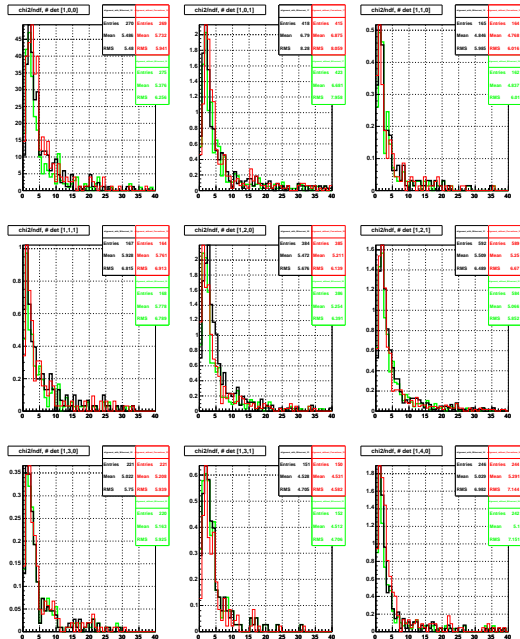
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Typical residuals for a cathode



- Here we applied the corrections found from Minjung or by Millepede to run4pp data that have magnetic field on.
- Legend:** **In green**, tracks without any corrections. **In black**, reconstruction with Minjung corrections. **In red**, the tracks have been corrected with the misalignments found by Millepede.
- Comments:** The corrections found by Millepede improve the residuals. Most of the half octant residuals are slightly better with Millepede's corrections than with MinJung's corrections.

χ^2 / ndf


- Legend:** In green, tracks have no corrections at all. In black, the reconstruction includes MinJung's corrections. In red, the tracks have been corrected with the misalignments found by Millepede.

- Comments:** The track χ^2 per degree of freedom has a mean almost always smaller with Millepede corrections than with MJ's corrections.

- The χ^2 / ndf confirms what is seen for the residuals.

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Alignment status:

- The global alignment finds relevant corrections for run3pp, aligning the last station, without magnetic field, that improves the tracks quality of run4pp with field on.
- Improvement over MinJung's corrections is small (notably there is only a very small gain in terms of number of tracks). This was more or less expected since
 - 1 Minjung did a good job;
 - 2 A reduced number of degree of freedom was used here for the global alignment (i.e. only a small fraction of the detector is aligned, and only along w).
- However, finding such corrections with the global method is easier to run and quicker: to study 330 000 events (as done for run3pp), it lasts no more than 2 days of work (and uses 20Go disk space for each dst reconstruction, each new geometry needs a reconstructions).
- The complete sets of plots for mutr residuals and χ^2 comparisons for run3pp and run4pp can be find at:
<https://www.phenix.bnl.gov/WWW/p/draft/silvestr/talks/Alignmentupdate.06.04.12/ps/>
- **The alignment should be used on run6.** We suggest that this method becomes the official one for alignment.

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Todo list:

- Run the alignment for all stations without field: it should give more improvement over MinJung's corrections.
- Run the alignment with field on, only Mutr: to check if there are misalignments when turning the field ON.
- Put the Muid in the kalman fit to align with field on, Mutr and Muid : compare with Melinda's corrections to see if better improvement can be achieved (this can also be done without field).
- We could find corrections from off field run4 data, and see if they match run3 corrections. This will tell us if there are any systematics misalignments between run 3 and run 4.
- Run the method on Run6.
- Start writing a technical note even if the work is not over.